A Short Guide To Metric Nuts and Bolts

Answers to the most Frequently Asked Questions

Standard and Fine Pitch Threads

How to identify nut and bolt strength grades

How nut and bolt strength grades compare

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Introduction: Metric Nuts and Bolts

This short guide is intended to give a very basic introduction to ISO metric nuts and bolts. It is intended for those working in plant and machinery maintenance to give enough information to ensure that correct replacement parts are identified and used.

Few parts are as critical in the assembly of modern machinery as the nuts and bolts which hold it all together and, at first sight, it seems that all metric bolts are basically the same.

In fact, of course, nothing could be further from the truth. There are no fewer than 5 different threads for different applications and 10 different standard strength grades defined for each size of bolt. There are nineteen standard sizes - known as the 'preferred ' sizes and ten less commonly used (the so-called 'non-preferred') sizes.

The situation is almost as complex with metric nuts which come in a wide variety of types (full, thin, nyloc, castellated.....) and 5 strength grades as well as the same range of sizes.

The difference in strength between different grades is quite dramatic: the highest standard grade being capable of carrying more than three times as much load as the lowest grade.

If you are responsible for repairing and maintaining machinery, particularly if that machinery is involved in lifting operations or other safety critical applications then you will be aware of the importance of fitting the right parts in the right way. This short guide is intended to give you the information you need to be able to correctly identify and use the metric nuts and bolts most commonly found in plant and machinery.

Disclaimer

Every effort has been made to ensure that the information contained in this document is correct but no guarantee can be given nor liability accepted for errors or omissions.

We are always grateful for any comments or criticisms of our technical publications and are happy to offer advice on all aspects of plant and machiery maintenance.

Should you have any feedback concerning this document please contact us:

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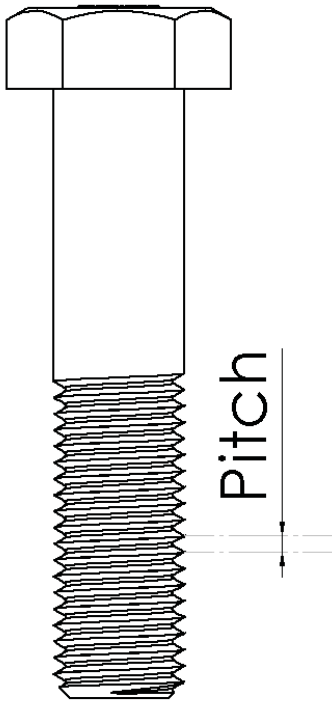
Standard and Fine Pitch Threads

Although various special threads are defined by the ISO standard only two are in common use in most machinery, the others are mainly used in specialist equipment such as precision instruments, optical instruments, etc.

The two threads most commonly found in plant and machinery are commonly known as ‘standard’ and ‘fine’ pitch.

The pitch of a thread is the distance between two adjacent threads and is measured in millimetres.

The most common thread diameter and pitch combinations found in plant and machinery are listed in the table below:



Size	Pitch (std)	Pitch (fine)
M5	0.8	
M6	1.0	0.75
M8	1.25	1.0
M10	1.5	1.0 or 1.25
M12	1.75	1.5
M16	2.0	1.5
M20	2.5	1.5
M24	3.0	2.0
M30	3.5	2.0

How to Identify the Strength Grade of Nuts and Bolts

Except for the very lowest grades, metric nuts and bolts all carry identification markings which indicate their strength.

On the head of each bolt are two numbers separated by a decimal point, the full list includes ten grades from 3.6 to 14.9 but in plant and machinery only grades 8.8, 9.8, 10.9 and 12.9 are normally found. The bolt head should also have a code - normally two or three letters - indicating the manufacturer.

Usually the markings are on the top of the bolt head but sometimes they are on the side.

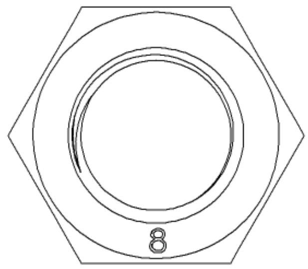
The first number gives the breaking strength of the steel in the bolt. In round terms it is in 10’s of kg per square millimeter of the bolt.

For example, a grade 12.9 bolt will not snap until every square millimetre of the bolt cross section is carrying a load of at least 120 kg. Similarly a grade 8.8 bolt will not snap until it is carrying a load of 80kg per square millimetre.

A bolt will begin to stretch before it finally breaks, the second number on the head of the bolt indicates how much of the breaking strength the bolt can stand before it starts to stretch.

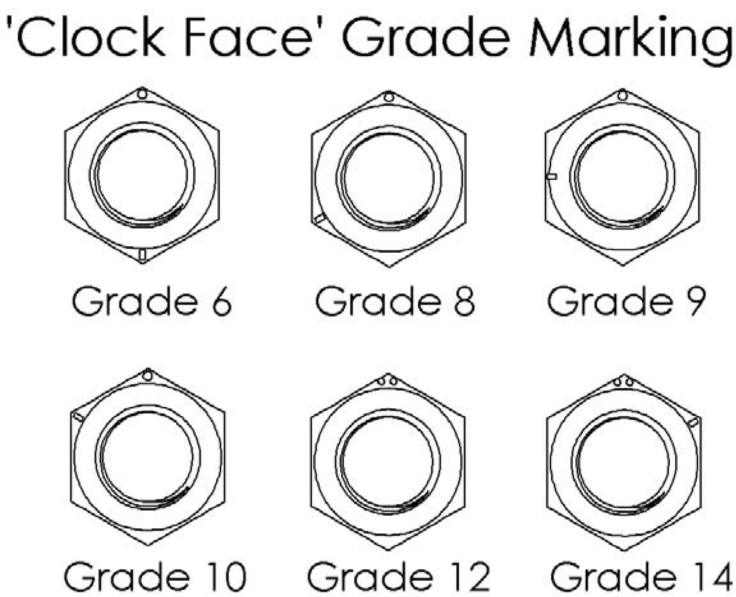
For example, a grade 12.9 bolt will begin to stretch when the load on the bolt is 90% of the breaking load. Similarly a grade 9.8 bolt will begin to stretch at 80% of its breaking load.

The strength grade marking is more difficult to see on metric nuts, sometimes it is given as a number, sometimes as a pattern of a dot and a line where the position of the line indicates the grade like the hands of a clock.



Where the grade is given as a number it may be stamped on the top of the nut or on one of the flat sides.

Clock face grade marks are shown in the illustration (right). Put the dot at the twelve O-Clock position and the line shows the grade.



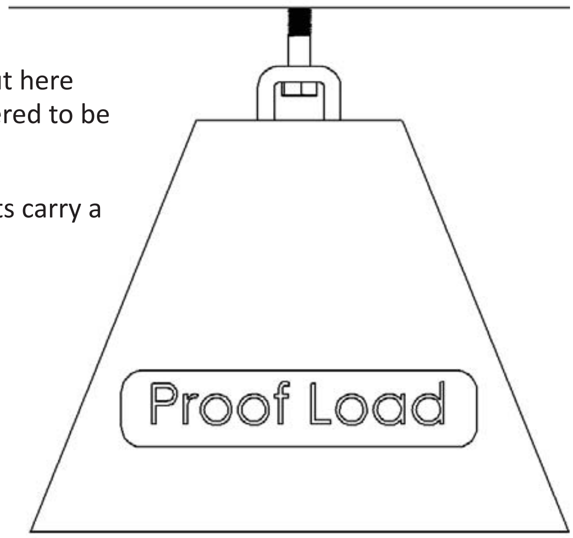
The rule is that the grade of the nut should always be the same as the bolt grade or one grade higher so: a grade 8.8 bolt should be fitted with a grade 8 or grade 9 nut. A grade 12.9 bolt should be fitted with a grade 12 or grade 14 nut.

How the Different Strength Grades Compare

As we said on page 4, if a bolt is gradually loaded there comes a point when it begins to stretch and after that a point where it actually breaks. When deciding how much load a bolt should be allowed to carry the standards define a 'proof load' - typically around 90% of the load at which the bolt begins to stretch.

Proof loads are normally given in Newtons in manufacturers tables but here we've converted them into kg force. The proof load is usually considered to be the absolute maximum load which a bolt should be asked to carry.

In practice, manufacturers will design their machinery so that the bolts carry a lot less than the proof load to give a good safety factor to the design.



Proof Loads for Standard Pitch Bolts

Size	Grade 8.8	Grade 9.8	Grade 10.9	Grade 12.9
M5	820 kg	923kg	1,180kg	1,380kg
M6	1,160kg	1,310kg	1,670kg	1,950kg
M8	2,120kg	2,380kg	3,040kg	3,550kg
M10	3,370kg	3,770kg	4,810kg	5,630kg
M12	4,890kg	5,480kg	7,000kg	8,180kg
M16	9,100kg	10,200kg	13,000kg	15,200kg
M20	14,700kg	N/A	20,300kg	23,800kg
M24	21,200kg	N/A	29,300kg	34,200kg
M30	33,700kg	N/A	46,600kg	54,400kg

Fine pitch bolts will be typically 10% stronger than coarse pitch bolts because less metal is cut away to make the thread.

Maximum Tightening Torques

The maximum recommended torques given in the table below assume that the threads are lightly oiled. Doing a bolt up to the specified torque should set the tension in the bolt to approximately 85% of the proof load given in the table on page 6.

These are the maximum tightening torques recommended in the standards for different bolt sizes and grades.

ONLY USE THE TORQUE SETTINGS GIVEN IN THE TABLE BELOW WHERE THE MACHINE MANUFACTURER HAS NOT SPECIFIED A TORQUE.

For Standard Pitch Bolts and Nuts

Size	Grade 8.8	Grade 9.8	Grade 10.9	Grade 12.9
M5	7.0 Nm	7.8 Nm	10.0 Nm	11.7 Nm
M6	11.8 Nm	13.3 Nm	17.0 Nm	19.9 Nm
M8	28.8 Nm	32.3 Nm	41.3 Nm	48.3 Nm
M10	57.3 Nm	64.1 Nm	81.8 Nm	95.7 Nm
M12	99.8 Nm	111.8 Nm	142.8 Nm	166.9 Nm
M16	247.5 Nm	277.4 Nm	353.6 Nm	413.4 Nm
M20	499.8 Nm	N/A	690.2 Nm	809.2 Nm
M24	865.0 Nm	N/A	1,195.4 Nm	1,395.3 Nm
M30	1,718.7 Nm	N/A	2,376.6 Nm	2,774.4 Nm

Fine pitch nuts and bolts are normally only used in special circumstances and the manufacturer's maintenance documentation should give the required torque in each case.

Fine threads are often used where a bolt is screwed into a soft metal block, such as an aluminium casting, the thread in the block may be far weaker than the bolt and a lower torque is almost always required to avoid stripping the threads.

Why Manufacturers Sometimes Specify a Lower Torque

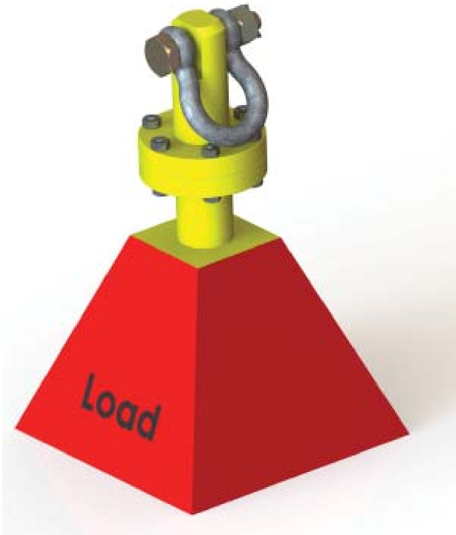
As well as where a bolt is screwed into a weak part, another important reason for reducing the torque setting of a nut and bolt is if the bolt is carrying other loads. An example of this is illustrated here where a bolted flange is carrying a heavy load.

When the bolts are tightened to join the flanges together the tighening of the bolts pre-loads them, using up some of the bolts' strength to squeeze the flanges together.

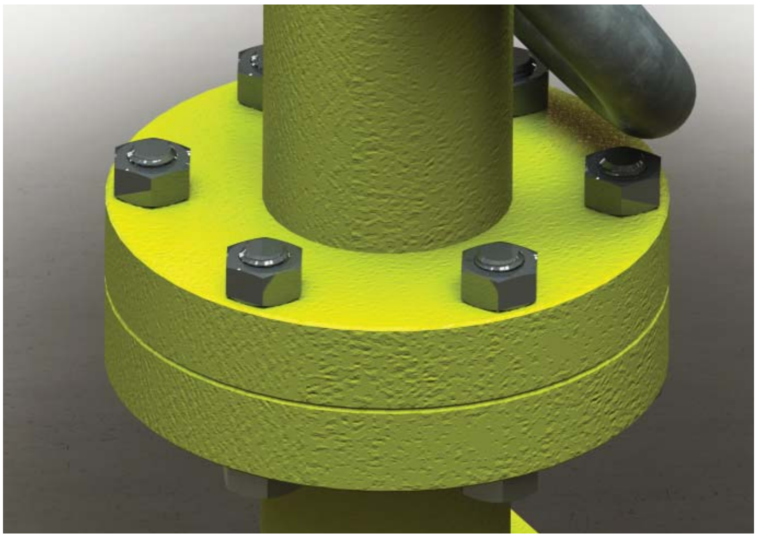
When the weight is picked up the bolts have to carry the weight as well . The weight is added to the pre-load on the bolts.

If the bolts are tightened to their maximum torque setting before the weight is lifted then most of their strength is used up in squeezing the flanges together and there may be too little strength left to support the weight.

In these circumstances the manufacturer may decide on a lower torque to use less of the bolts' strength on squeezing the flanges together and leave more strength available for carrying the weight.



Always refer to the machine manufacturers' maintenance documentation for the specified torque of bolts and nuts used in lifting and load bearing applications.



Spanner and Allen Key Sizes

Correct Spanner and Allen Key sizes are given in the table below for the normal range of bolt and nut sizes found in plant and machinery.

To minimise the risk of a spanner slipping and marring the corners of a fastener, it is good practise to use ring spanners (or the ring end of a combination spanner) whenever possible.

Size	Spanner	Allen Key
M5	8 mm	4 mm
M6	10 mm	5 mm
M8	13 mm	6 mm
M10	17 mm	8 mm
M12	19 mm	10 mm
M16	24 mm	14 mm
M20	30 mm	17 mm
M24	36 mm	19 mm
M30	46 mm	

Tapping Drill and Clearance Hole Drill Sizes

Metric bolts are made fractionally under their stated size, for instance an M16 bolt will have a shank diameter of typically 15.97mm. This means that a 16mm bolt will fit through a 16mm hole but to allow for misalignment between parts it is common practice to drill bolt holes slightly larger. These are known as clearance holes.

Typical clearance hole sizes are given in the table below along with the correct tapping hole size for each size of standard and fine pitch thread.

With metric threads tapping drill size is easy to work out because it is the bolt diameter minus the thread pitch so, for example, a standard pitch M16 bolt has a pitch of 2.0mm so the tapping drill size is 16 - 2 = 14mm.

The table below gives tapping drill sizes for threads corresponding to the thread pitches given in the table on page 3.

Size	Clearance Hole	Thread Pitch (std)	Tapping Drill (std Pitch)	Thread Pitch (fine)	Tapping Drill (fine pitch)
M5	5.5	0.8	4.2 mm		
M6	6.5	1.0	5.0 mm	0.75	5.25 mm
M8	9	1.25	6.75 mm	1.0	7 mm
M10	11	1.5	8.5 mm	1.0 or 1.25	9.0 or 8.75 mm
M12	14	1.75	10.25 mm	1.5	10.5 mm
M16	18	2.0	14 mm	1.5	16.5 mm
M20	22	2.5	17.5 mm	1.5	20.5 mm
M24	26	3.0	21 mm	2.0	24 mm
M30	32	3.5	26.5 mm	2.0	30 mm

When tapping a hole, particularly M10 and smaller, remember to keep removing the tap from the hole and blowing away the swarf to prevent the tap jamming and breaking.

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